Impact of disruptions on anaesthetic workflow:

A prospective study during anaesthesia induction and patient positioning

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Abstract

Background: Work disruption in operating rooms (ORs) hinders flow of patients and increases chances of error. Previous studies have largely focused on the types of disruption occurring in ORs, but have not analyzed systematically the objective impact of disruptions.

Objective: To evaluate the impact of disruption on time-efficiency in pre-operative anaesthetic work in the OR and to link disruptions to failures in coordination of care.

Design: Prospective, cross-sectional, observational study.

Setting: Disruptions were evaluated in ORs of 5 hospitals across 3 countries: Australia (1 community hospital, 1 teaching hospital); Thailand (2 community hospitals); China (1 teaching hospital).

Participants: The pre-operative phase of anaesthesia induction/patient positioning (POP) of 64 surgical patients across specialities was prospectively evaluated (Australia=33; Thailand=12; China=10). Further, interviews were carried out with 16 Consultant physicians (anaesthetists and surgeons) and 13 senior OR nurses involved in the care of these patients.

Main outcome measures: Disruptions were identified by trained observers in real-time during POP; 4 types of care coordination problems were derived from the interviews with senior anaesthetists, surgeons, and nurses, and linked to the disruptions. Descriptive analyses of time-efficiency were performed.

Results: Complete data were available from 55 cases. Good inter-observer agreement was obtained across measurements (range 74-92%). An average of 3 disruptions per case during POP were observed (range 2-9). *Disruption types*: disruptive staff activities were associated with most time-wasting (median=1min/case, range 00mins:00secs to 4mins:45secs per case). *Care coordination problems*: coordination lapses within the OR team, and between them and the preoperative team were associated with most time-wasting (median=1min/case, range 00mins:00secs to 5.00mins:00secs per case).

Conclusion: The study quantifies time-inefficiencies affecting anaesthetic work during POP. Avoidable work disruptions could be reduced.

Introduction

Disruption to the anaesthetic work during the preoperative phase (POP) of surgery delays surgery, or unnecessarily prolongs the patient journey[1]. Although some of the evidence is descriptive[2], we know that disruption can affect patient safety and is a problem in the operating room, OR[3-5]. Many disruptions are due to controllable factors, e.g., poor care coordination. Such preventable disruptions may be minor (e.g., a phonecall) – but their accumulation increases workload[4,6], creates stress/fatigue and predisposes to error[7-9].

Studies have described disruptions in ORs and developed tools to assess them[10,11]. Other studies have attempted to reduce ergonomic deficiencies that cause disruption[12-15]. Some studies have measured the impact of disruption during OR turnover time[16], non-operative time[17], operative time for minimally invasive surgery[18], and intraoperative processes[1,10,11,19-21]. Recent anaesthetic studies have identified disruptions during anaesthesia induction, but also throughout the perioperative pathway from anaesthesia room to recovery[22-25]. Yet other studies have investigated the impact of disruptions on time-efficiency in the OR. Al-Hakim and Gong[26] provided a prospective assessment of the impact of disruption on operative time, whereas Gillespie et al[27] assessed actual vs. expected operative time (as judged by operating surgeons), and linked these to intra-operative disruptions. Healey et al[21] found that interruptions added an average 6mins to each case.

This study aimed to (i) systematically investigate the time added to anaesthetic work through disruptions during pre-anaesthesia, anaesthesia induction and patient positioning and (ii) to identify specific care coordination problems causing disruptions.

Methods

Study design and setting

This was a prospective observational study of disruptions occurring during pre-anaesthesia, anaesthesia induction and patient positioning stages, i.e. in the preoperative phase (POP) of care.

Observations were conducted in two Australian hospitals; one community hospital (8 ORs) and the other one was a large metropolitan teaching hospital (22 ORs); two hospitals in Thailand (community hospitals, 18 ORs); and one hospital in China (teaching hospital, 16 ORs). These hospitals were selected based on availability sampling. Due to the descriptive nature of the study and the small number of hospitals overall, we did not have, nor did we test, specific hypotheses about cultural, organizational or other differences across hospitals or countries.

Definition of disruptions and care coordination

We defined disruption as any undesirable event, which is either not part of the planned process, or not implemented as planned. The perioperative pathway comprises a chain of interrelated activities, which should be performed in a timely sequence, i.e., they should be coordinated. A disruption in one part of the pathway may disturb the work in other parts – e.g., a patient arriving from the ward to the anaesthesia room for induction of anesthetic without their notes disrupts the process. We use the term 'care coordination' to refer to instances of synchronization and integration of work across the perioperative pathway – including between different hospital departments, teams and individuals. In this study, we took a bottom-up approach and elicited the views of clinical experts to inform our thinking

about care coordination problems and lapses that were associated with subsequent disruption to anaesthetic work (see study procedure).

Ethics

Ethical approval for this study was provided by the Human Research Ethical Committee of the Toowoomba & Darling Downs Health Service District, Queensland, Australia (Human Research Ethical Committee No. TDDHSD HREC 2007/027, Chairperson: Dr Scott Kitchener) on July 3rd 2008. Participating hospitals approved the study internally.

Study procedure

The research procedure comprised 3 stages; observer training, process mapping, and observation.

Observer training: Two observers carried out the observations. The first observer (LAH) has an industrial engineering background with >40 years of experience in human factors and system analysis in industry and academia. In the Australian hospitals, the second observer was a postgraduate student with human factors training. In the Thai and Chinese hospitals, the second observer was an experienced OR nurse. All observers underwent training to ensure uniformity and quality-assure the observations. The observers first reviewed the available literature on type and magnitude of disruptions in ORs. For training purposes, all observers conducted preliminary training observations in ORs under the supervision of a Consultant anaesthetist. The anaesthetist explained the surgical care pathway to the observers and explained to them what they were observing (from pre- to postoperative phases). The anaesthetist also arranged for the observers to meet and discuss disruptions in the OR with a

team of senior surgeons and scrub nurses to further improve the observers' understanding of disruptions and their causes. The training lasted 6 weeks – during which the observers were trained 3 days per week and observed a total of 12 full procedures. The last 5 of these were analyzed and showed high consistency between observers in identifying disruptive events, their effect on surgical flow and in identifying the problems causing the disruptions.

Expert-derivation of care coordination problems: the research team met with a liaison officer, 2-3 OR nurses and at least one Consultant surgeon and one Consultant anaesthetist in each hospital. The liaison officers were staff-members (usually OR administrators) allocated by the hospital to liaise with the study team in terms of study approvals and access to ORs. They accompanied observers, introduced them to teams and arranged meetings. The first meeting was conducted to understand how the perioperative flow process breaks down into activities. Subsequent meetings followed an iterative pattern: the first part of the meeting was used to review and revise the process chart completed as a result of information collected from the previous meeting; sub-processes and activities for POP were highlighted for further analysis.

To gain insights into potential care coordination problems linked to disruptions, we interviewed senior anaesthetists, surgeons and nurses as well as surgical service managers at each hospital. The interviews were semi-structured, lasted approximately 20mins each, and were carried out at a place and time convenient to the participant. The interviews aimed to identify causes of preventable disruption during POP. Experts were asked to consider their practice of OR working and to identify where bottlenecks appear preoperatively; what disrupts patient flow; what causes delays, or safety concerns; and what they consider the origins of these problems/concerns. The interviewer (LAH in all cases) took notes in real

time, which were subsequently submitted to simple content analysis[28], alongside the process charts that we obtained in this phase, to provide the categories of care coordination problems that the observers linked to disruptions during POP.

Observation: the liaison officer obtained the operating list, introduced the observers to patients and staff and explained the purpose of the observation and the anonymity of staff and patients. The observations covered the time taken for POP, starting from the patient being ready for pre-anaesthesia and ending when the patient was ready for incision, any disruptions that took place. The observed events were recorded on a structured proforma divided into fields showing the type, the start time and the end time for each recorded event (which were manually recorded by the observer). Table 1 reports the categories of disruption that were assessed and their definitions. Time taken as a result of a disruptive event was measured manually in 15sec intervals (for practical purposes).

Upon completion of each procedure, the observers reviewed the disruptions and their causes with the study liaison officers and with a member of the operating team if clarification was needed. Data was subsequently entered into a spreadsheet for analysis.

Results

Care coordination problems leading to disruptions: expert views

Interviews were carried out with 16 Consultant anaesthetists and surgeons and 13 senior OR nurses (Table 1). Similar preoperative care coordination problems were found across all 3 countries. Participants highlighted the importance of having timely coordination between the OR team and pre-operative staff as well as with the OR management team. Accurate and

timely available communication and information flow, written and verbal, between different departments was mentioned as a key contributor. They further emphasized the importance of team briefings immediately before surgery to minimize disruption later within their own teams and also in postoperative care but were doubtful about the effectiveness of the current briefing practices across all study hospitals.

Through our content analysis, the following care coordination problems were derived:

1. Coordination between surgical department and other departments prior to POP;
2. Coordination between OR administration/management services other than the surgical department prior to/during POP;
3. Coordination within pre-operative team (i.e., the team who receive/prepare the patient immediately prior to them having surgery) and between pre-operative and OR teams prior to/during POP;
4. Coordination within the OR team during POP.

These were based on the 'bottlenecks' and problems identified by the subject matter experts and the origins of these as viewed by them, which we reviewed and defined into the four care coordination problems based on our extensive experience in perioperative pathways (the disruptions that may occur during POP and their associated care coordination problems as derived from these interviews and our analysis are described in the Appendix).

Descriptive information and demographics of observed procedures

Data during POP for 64 observed surgeries were analyzed, of which 55 had complete datasets (cases were excluded due to unexpected termination of anaesthesia induction, patient complexities, and incomplete data collection). Thirty-three cases were observed in Australian hospitals (21 in urban/teaching and 12 in regional/community hospitals), 10 in Chinese

hospitals, and 12 in Thai hospitals (Table 1). Procedures were elective (including general, oncologic and urologic surgery), carried out under general anaesthesia and were led surgically and anaesthetically by a senior, Consultant/Attending level physician and by at least one senior scrub nurse; anaesthesia and surgical assistants were present during POP. At the time of the data collection, all study hospitals had a local version of the WHO Surgical Safety Checklist implemented alongside their normal perioperative protocols; anaesthesia was carried out in anaesthesia rooms adjacent to the OR in the Australian hospitals and within the OR in the Chinese and Thai hospitals. Patient positioning for the majority of observed surgeries was regular or modified supine position (n=32). Other positioning included 7 cases with lateral positioning, 6 cases with prone position, 6 cases with lithotomy and 4 cases with fowler position. In terms of clinical procedures, average POP duration ranged from approximately 15mins for supine positioning to 26mins for fowler positioning. Due to the ethical approval requirement, no further patient- or procedure level data, or team-level data were collected from these cases.

Observed disruptions

Percentage (%) agreement was used to measure the consistency within pairs of observers (inter-observer reliability) in the number of disruptions they recorded and their type. High level of agreement was obtained in the number and type of disruptive events ranging from 84% to 92% across hospitals. Good agreement was also obtained for the care coordination problems that led to disruptions as attributed by the observers (range 74% to 87% across hospitals).

Per case observed, we recorded a median of 3 disruptions during POP (minimum=2, maximum=9). Disruptive events resulting from staff activities (the 3rd type of disruption defined in Table 2) prolonged the POP period more than others (Table 3); in many occasions, such activities involved corrections that needed to be made. Examples include having received the wrong or faulty attachment necessary for patient positioning on the table; discovering a fault in the anaesthesia equipment during POP; and reconfiguring lines. Although in most cases these activities took approximately 1min, staff-related disruptions added in some cases an extra of approximately 3-5mins per patient. Disruptions due to team activities, mainly what we defined as 'team participation', had the second largest impact on time taken, adding just under 1min per patient and on some occasions up to 2 and a half minutes; these were largely due to staff (e.g., surgeon or assistants) being absent thus delaying proceedings. Further, we observed some variation in the time taken by disruptive events depending on the care coordination problem that triggered them (Table 4): approximately 1min per patient on average was added to the POP time due to disruptions within the OR team themselves or in their interaction with the preoperative team. Examples of such disruptions include wrong instrumentation available (a disruption within the OR team), or delay in moving a patient to OR as a result of miscommunication between the OR team and the preoperative team. These two types of coordination lapses also had the maximum impact on POP duration, as they were found to add up to between 3 and 5mins to the POP duration.

Discussion

This study extends our overall understanding of the impact of disruptive events on perioperative care – specifically the preoperative stage of care, from pre-anaesthesia, to anaesthesia induction and subsequently patient positioning for surgery. Across ORs in three

countries, we found an average of 3 disruptive events per case. Disruptive staff activities were associated with most time-wasting (on average 1min, but up to almost 5mins per case). Further, we were able to elicit specific lapses in care coordination (from experienced OR personnel), to which we subsequently linked these disruptions. Coordination lapses within the OR team and also between them and the preoperative team (who receive and prepare the patient for surgery) were associated with most time-wasting (on average 1min each, but up to 5mins per case).

These findings are perhaps not surprising – disruptions and interruptions to care delivery have been described as ever present during POP but also during surgery and postoperatively[1,3-5,10,11,19-25]. What this study offers is a time-based, objective analysis (within the limits of the human observers' capabilities) of the added inefficiencies of such disruptions: they simply add time to the procedures. This has implications for overall perioperative efficiency. The study illustrates that coordination lapses within the OR team as well as between them and the preoperative team are the biggest contributors to time wasting. These disruptions were preventable – and hence this study adds evidence that better teamwork is required not only to enhance patient safety (as most of the literature shows[29]) but also to improve efficiency in perioperative care. The staff-related disruption and associated time-wasting that we found was often related to equipment – lack of availability, wrong equipment, or malfunctioning equipment. Equipment related problems in OR are well-established[30] – they cause significant levels of disruption, which here we show is linked to inefficiency. Such problems can be reduced via better planning and checking, as shown in a recent systematic review[30] – effectively, the OR team often find themselves addressing problems which they should not be faced with at that time (i.e. when the patient is being readied and put to sleep) in the first instance. There is, therefore, an organizational element to

OR teamworking – for the OR team to function efficiently problems upstream from the OR need to be addressed.

It could be argued that there is another aspect to our dataset – namely the teams we observed may be showing signs of resilience by addressing problems as these arise, thus reinforcing the reliability of the perioperative pathway[31]. This is certainly an interesting argument – however, we consider it somewhat problematic when applied to the extent that we found. We found numerous disruptions, which could have been avoided. The perspective we took was based on ergonomics and process optimization, which focuses on inefficiencies[32,33]. The teams did think 'on their feet' – they did not have any alternative. Our argument is that the potential level of inefficiency and disruption in the OR may not be ideal. We would further propose that if avoidable disruption becomes minimized then OR teams would have more 'mindspace' (i.e., cognitive capacity) to respond to complexities and pressures requiring true team resilience. Further research should test this proposition.

Limitations

This study has limitations. It can be argued that the number of observations is relatively small and selective, and the results may not be generalizable (e.g., we might have gravitated towards the more 'regular' cases, where time efficiency may be less critical than in emergencies). We also relied on human observers mechanically allocating time measurements. Further, we included an element of qualitative, thematically analyzed data, which inevitably carry a possibility of bias through participants' own and our research team's subjective perspectives. The study also has strengths – including the combination of

qualitative and quantitative measures across three countries; the multidisciplinary, clinical and ergonomic, perspective on the research question; and the trained observers.

Conclusion

The study quantifies time-inefficiencies affecting anaesthetic work during POP. We found an average 3 disruptions affecting POP per case. Disruptions involving personnel caused most time-wasting, adding an average 1min/disruption/case to the work. Such disruptions have an impact on OR efficiency, and can subsequently affect safety, and can be reduced.

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Conflict of interest: NS is the director of London Safety and Training Solutions ltd, which provides safety and team training and advisory services on a consultancy basis.

Presentation: None

References

1. Wiegmann DA, ElBardissi AW, Dearani JA et al. Disruptions in surgical flow and their relationship to surgical errors: An exploratory investigation. *Surgery* 2007;**142**:658-65.
2. Grundgeiger T, Sanderson P. Interruptions in healthcare: Theoretical views. *Int J Med Inform* 2009;**78**:293-307
3. Sevdalis N, Forrest D, Undre S et al. Annoyances, Disruptions, and Interruptions in Surgery: The Disruptions in Surgery Index (DiSI). *World J Surg* 2008;**32**:1643-50.
4. Weigl M, Antoniadis S, Chiapponi C, Bruns C, Sevdalis N. The impact of intra-operative interruptions on surgeons' perceived workload: an observational study in elective general and orthopedic surgery. *Surg Endosc* 2015;**29**:145-53.
5. Tschan F, Seelenadt JC, KEller S et al. Impact of case-relevant and case-irrelevant communication within the surgical team on surgical-site infection. *Br J Surg* 2015;in press
6. Weigl M, Müller A, Vincent C et al. The association of workflow interruptions and hospital doctors' workload: a prospective observational study. *BMJ Qual Saf* 2012;**21**:399-407.
7. Arora S, Sevdalis N, Nestel D, Tierney T, Woloshynowych M, Kneebone R. Managing intra-operative stress: What do surgeons want from a crisis training programme? *Am J Surg* 2009;**197**:537-43.
8. Larsson J, Sanner M. Doing a good job and getting something out of it: On stress and well-being in anaesthesia. *Br J Anaesth* 2010;**105**:34-7.
9. Sevdalis N, Arora S, Undre S, Vincent CA. Distractions and interruptions in the operating room. In R Flin, L Mitchell (Eds.) *Safer Surgery: Analyzing Behaviour in the Operating Theatre* (pp. 405-422). Ashgate. 2009.
10. Healey AN, Sevdalis N, Vincent C. Measuring intraoperative interference from distraction and interruption observed in the operating theatre. *Ergonomics* 2006;**49**:484-512.
11. Henrickson Parker S, Laviana AA, Wadhera RK et al. Development and evaluation of an observational tool for assessing surgical flow disruptions and their impact on surgical performance. *World J Surg* 2010;**34**:353-61.
12. Buchel D, Marvik R, Hallabrin B. Ergonomics of disposable handles for minimally invasive surgery. *Surg Endosc* 2010;**24**:992-1004.
13. Matern U, Koneczny S. Safety, hazards and ergonomics in the operating room. *Surg Endosc* 2007;**21**:1965-9.
14. Selvaggi G, Khater M, Humzah M et al. Time and motion in cosmetic surgery. *Plast Surg Nurs* 2010;**30**:14-9.
15. Desjardins F, Cardinal L, Belzile E, McCusker J. Reorganizing nursing work on surgical units: a time-and-motion study. *Nurs Lead* 2008;**21**:26-38.
16. Adams R, Warner P, Hubbard B, Goulding T. Decreasing turnaround time between general surgery cases: a six sigma initiative. *JONA* 2004;**34**:140-8.

17. Buchel D, Marvik R, Hallabrin B. Ergonomics of disposable handles fr minimally invasive surgery. *Surg Endosc* 2010;**24**:992-1004.
18. Al-Hakim L. The impact of preventable disruption on the operative time for minimally invasive surgery. *Surg Endosc* 2011;**25**:3385-92.
19. Harders M, Malangoni MA, Weight S, Sidhu T. Improving operating room efficiency through process redesign. *Surgery* 2006;**140**:509-16.
20. Al-Hakim L. Surgical disruption: information quality perspective. *Int J Inform Qual* 2008;**2**:192-204.
21. Healey AN, Primus CP, Koutantji M. Quantifying distraction and interruption in urological surgery. *Qual Saf Health Care* 2007;**16**:135-9.
22. Savoldelli GL, Thieblemont J, Clergue F, et al. Incidence and impact of distracting events duricng induction of general anesthesia for urgent surgical cases. *Eur J Anaesthesiol* 2010;**27**:683-9.
23. Campbell G, Arfanis K, Smith AF. Distraction and interruption in anaesthetic practice. *Br J Anaesth* 2012;**109**:707-15.
24. Jothiraj H, Howland-Harris J, Evley R, Moppett IK. Distractions and the anaesthetist: a qualitative study of context and direction of distraction. *Br J Anaesth* 2013;**111**:477-82.
25. Broom MA, Capek AL, Carachi P, Akeroyd MA, Hilditch G. Critical phase distractions in anesthesia and the sterile cockpit concept. *Anaesthesia* 2011;**66**:175-9.
26. Al-Hakim L, Gong XY. On the day of surgery: how long does disruption prolong the patient journey? *Int J Health Care Qual Assur* 2012;**25**:322-42.
27. Gillespie B, Chaboyer W, Fairweather N. Factors that influence the expected length of operation: results of a prospective study. *Qual Saf Health Care* 2012;**21**:3-12.
28. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descritpive study. *Nurs Health Sci* 2013;**15**:398-405.
29. Sevdalis N, Hull L, Birnbach DB. Improving patient safety in the operating theatre and perioperative care: Obsacles, interventions and priorities for accelerating progress. *Br J Anaesth* 2012:**109**:i3-16.
30. Weerakkody RA, Cheshire NJ, Riga C, et al. Surgical technology and operating-room safety failures: a systematic review of quantitative studies. *BMJ Qual Saf* 2013;**22**:710-8.
31. Hollnagel E, Braithwaite J, Wears RL. *Resilient health care*. Farnham, UK: Ashgate, 2013.
32. Carayon P, Hundt AS, Karsh B-T et al. Work system design for patient safety: The SEIPS model. *Qual Saf Health Care* 2006;**15**:i50-8.
33. Wiegmann DA, Eggman AA, ElBardissi AW et al. Improving cardiac surgical care: A work systems approach. *Applied Ergon* 2010;**41**:701-12.

TABLES

Table 1. Study demographic information (for observations and interviews conducted)

Observations				
Country		**Australia**	**Thailand**	**China**
Observers		**2 observers** **1 experienced industrial & systems engineer (LAH), 1 trained postgraduate human factors observer**	**2 observers** **1 experienced industrial & systems engineer (LAH), 1 trained senior OR nurse**	**2 observers** **1 experienced industrial & systems engineer (LAH), 1 trained senior OR nurse**
Cases observed, N		33	12	10
OR personnel included in observations	Consultant Surgeons	14	7	7
	Consultant Anaesthesiologists	17	7	6
	Assistant Surgeons	25	13	12
	Assistant Anaesthesiologists	17	7	6
	Scrub nurses*	16	8	7
Interviews#				
Interviews conducted, N		14	9	6
OR personnel included in interviews	Consultant Surgeons	6	3	3
	Consultant Anaesthesiologists	3	1	-
	OR nurses	5	5	3

Notes: *There were at least 2 circulators in each one of the observed cases; #All interviews were conducted by the LAH (first author).

Table 2. Types of disruptions assessed preoperatively (from pre-anaesthesia to patient positing for surgery)

Types of disruptions		Description
1. Patient record & information		This includes disruption resulting from missing, incomplete, or out-of-date information in the patient record, including missing or incomplete reports or tests.
2. Patient	**2.1 Readjustment**	Disruptive events resulting from readjusting patient' drape, dress or any parts of the patient's body.
	2.2 Behaviour	Unexpected patient's behaviour or health status that create disruption and affect the progress of POP.
3. Staff activities	**3.1 Correction**	This factor includes disruptive events resulting from erroneously performed POP activities that require correction or adjustment. Examples include having wrong instruments or sterile package or changes to anaesthesia equipment, attachments or operating table.
	3.2 Receiving & changing	Receiving unsuitable instruments, attachment or wrong sterile package. This includes also disruption resulting from changes in surgery schedule/list or of OR.
	3.3 Timing	Performing an activity that should be performed before the start of anaesthesia induction. Example includes repairing the anaesthesia equipment during POP.
4. Team involvement	**4.1 Participation**	This factor includes disruptive events resulting from unavailability of a member of the OR team, (e.g., surgeon), or performing an activity that may require more participants (e.g., transferring patient from trolley to operating table).
	4.2 Discussion & training	Disruptive events resulting from team discussion or ongoing training/teaching activity.
5. Others	**5.1 Searching**	Searching in OR for material or instrument that disturbs the progress of POP.
	5.2 Extraneous disruption	Disruption resulting from answering telephone calls, pagers, or staff (not part of OR team) who enter the OR during POP.

Note: POP = preoperative phase of surgery (including pre-anaesthesia, anaesthesia induction & patient positioning); OR = operating room

Table 3. Time wasted during the preoperative phase across different types of disruption

Types of disruptions	Time wasted (recorded in 15sec increments)	
	Median	**Range (Min; Max)**
1. Patient record	00mins 00secs	00mins 00secs; 01min 30secs
2.1 Patient readjustment	00mins 30secs	00mins 00secs; 02mins 00secs
2.2 Patient behaviour	00mins 00secs	00mins 00secs; 02mins 30secs
3.1 Staff activity-Correction	01min 00secs	00mins 00secs; 04mins 45secs
3.2 Staff activity-Receiving & changing	00mins 00secs	00mins 00secs; 03mins 45secs
3.3 Staff activity-Timing	00mins 00secs	00mins 00secs; 03mins 30secs
4.1 Team-Participation	00mins 45secs	00mins 00secs; 02mins 30secs
4.2 Team-Discussion & instruction	00mins 00secs	00mins 00secs; 00mins 45secs
5.1 Searching	00mins 00secs	00mins 00secs; 00mins 30secs
5.2 Extraneous disruption	00mins 00secs	00mins 00secs; 00mins 15secs

Table 4. Time wasted during the preoperative phase across different care coordination problems

Care coordination problems	Time wasted (recorded in 15sec increments)	
	Median	**Range (Min; Max)**
Between surgical & other services	00mins 30secs	00mins 00secs; 02mins 15secs
Between OR admin/management, labs & sterility services	00mins 00secs	00mins 00secs; 02mins 30secs
Between pre-operative & OR teams	01min 00secs	00mins 00secs; 03mins 15secs
Within OR team	01min 00secs	00mins 00secs; 05mins 00secs

Appendix. Types of disruptions preoperatively phase and associated care coordination problems

Types of disruptions	Care coordination problems				Comments
	Between surgical & other services	Between OR admin/management, labs & sterility services	Between pre-operative & OR teams	Within OR team	
1. Patient record & information	√	√	√		Accountability for having missing, outdated or incomplete information depends on the department responsible for creating or entering patient-related information.
	√				This could occur when the surgeon neglects to request specific test or explain requirements before the day of surgery.
		√			In some cases, surgeon asked for a specific test but no action was taken by relevant department.
2.1 Patient readjustment				√	Patient's body or parts may require readjustment for variety of reasons, including an error in positioning, better exposing the surgical area or changing an attachment.
			√		Unsuitable action or omission of pre-operative staff may create delay and extra effort for surgical team. E.g., OR team facing difficulty in untying the patient's gown. It is the responsibility of pre-operative staff to instruct and help the patient to wear the gown correctly.
2.3. Patient behaviour		√	√	√	Disruption occurs if there is a delay in moving a patient to OR. E.g., patient may arrive on time to the hospital registration office but then get lost on the way to pre-operative area. Includes delays in preparing the patient in pre-operative area due to the patient.
	√				Patient's aggressive or uncooperative behaviour creating disruption.
		√			Patient requires interpreter but OR management did not take action.
3.1 Staff activity-Correction	√	√	√		Failure to bring specific attachments or fixture etc. to OR could be failure of surgeon to specify correctly the requirements or failure of other departments to address surgical requirements.
	√				Surgeon omits or specifies incorrectly one of more of the surgical requirements.
		√			Failure of OR admin/management or sterility departments to address surgical requirements – e.g., failure to inspect correctness of surgery and anaesthesia equipment before the surgery.
			√		Disruption results from correcting a wrongly performed pre-operative activity.
				√	Disruption results from correcting a wrongly performed surgical activity during POP.
3.2 Staff activity-		√	√		OR management and pre-operative team may change OR without informing OR team.
		√			OR service directs sterile equipment to wrong OR.

Receiving & changing				√	Surgical team fails to verify the patient sterile package before surgery.
3.3 Staff activity-Timing		√	√		Failure to perform specific activities (e.g., maintenance of equipment) as per schedule is the responsibility of OR management or sterility department.
4.1 Team-Participation		√	√	√	Team availability: Depends on the activity and the department scheduling/planning it. Activities should be planned in advance and performed with the scheduled number of staff. Otherwise disruption occurs.
		√		√	Familiarity with equipment: Surgeon and anaesthetist should familiarise themselves with instruments and equipment. The possibility exists that OR management provides new equipment without informing surgeon / anaesthetist or without having trained staff to use it.
				√	This includes disruption from activities performed by the OR team during POP.
4.2 Team-Discussion & training				√	This includes disruptive events during training/teaching or involvement in discussion.
5.1 Searching		√		√	Disruption resulting from searching for instruments or materials in the OR. This could be due to OR management changing the location of equipment and instruments without informing the team.
5.2 Extraneous disruption			√	√	Staff enter and leave the OR disrupting POP.
				√	Delay resulting from answering irrelevant calls. Most calls to surgeon could be taken (or initially filtered) by a circulator.
			√		Disruption can be reduced when non-urgent calls to team during surgery are taken in the preoperative area.

Note: POP = preoperative phase of surgery (including pre-anaesthesia, anaesthesia induction & patient positioning); OR = operating room